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THE ROLE OF SCIENCE AND TECHNOLOGY IN THE CONTEXT OF INTERNATIONAL SECURITY, DISARMAMENT AND OTHER RELATED FIELDS

The application of science and technology for verification purposes

Working paper submitted by Canada

Introduction

In its resolution 43/81 B of 7 December 1988, the General Assembly endorsed 16 verification principles recommended by the Disarmament Commission. These principles included the recognition that "adequate and effective verification is an essential element of all arms limitation and disarmament agreements". Another of these general principles recognized that "adequate and effective verification requires employment of different techniques, such as national technical means, international technical means and international procedures, including on-site inspections". 1/

During the course of discussions in the Disarmament Commission Working Group on Verification in All Its Aspects, during 1987 and 1988, it was evident that advanced technical and scientific methods play an indispensable role in the verification process and that they will continue to do so. The report of the Group of Qualified Governmental Experts to Undertake a Study on the Role of the United Nations in the Field of Verification 2/ echoed this view. That study inter alia surveyed a variety of verification methods including those involving advanced technology, noted that new ideas and monitoring techniques for verification are continually being generated and refined, noted as well that no single verification tool is likely to be sufficient for any accord (a

synergistic and overlapping application of numerous approaches and devices is likely to be needed), and highlighted in particular the role that the United Nations can play in helping to facilitate the dissemination of information on research relating to cooperative arrangements for verification.

As this previous work within the United Nations has indicated, it is fair to say that science and technology plays a central role in providing solutions to the verification of arms control agreements. The 1960s and 1970s, for example, saw tremendous strides in the development of overhead remote sensing technologies for military intelligence and other purposes. These advances involved the use of remote sensors or, as they have come to be known, "national technical means" (NTM), to monitor events from great distances. The ability of the superpowers to adapt certain of these remote sensing techniques to arms control verification greatly facilitated the negotiation of significant bilateral strategic arms limitation agreements during the 1970s and 1980s. Gradually, the lessons learned in the bilateral context have been applied to the multilateral process, most recently in the use of overhead imagery and of on-site inspection techniques. The experience of the United Nations inspections in Iraq under Security Council resolution 687 (1991) is an excellent example of a multilayered approach to the verification of compliance.

Canada's Verification Research Program

Science and technology by their nature involve research activities. This research process can be focused directly on relevant verification questions. Canada's Verification Research Program has sought to do just this, recognizing the role that advanced science and technology has to play in multilateral verification activities. At the foundation of this Program, from its inception in 1984, is the assumption that research into verification provisions and techniques can be profitably conducted independent of specific negotiation contexts. Such efforts can be productive in generating new ideas and solutions to specific problems and overcoming obstacles in specific negotiations.

The verification requirements in certain agreements may be so complex that, without substantial preconsideration of verification questions, negotiations may founder and agreements may become impossible to conclude. Therefore, it is crucial that there be attempts to address verification concerns beginning in the earliest stages of agreement consideration. Moreover, technologies and procedures for verification purposes must be continually discussed, researched and updated if verification capabilities are to keep pace with the demand placed on them through relentless technological development and increasingly complex arms limitation agreements.

Not only can the study and consideration of verification help allay concerns about possible abuses of the verification process but it can also facilitate arms control and disarmament. There are many initiatives that can be undertaken to prepare and develop a range of instruments - legal, institutional and technological - that could contribute to the potential for the verification of specific agreements. General research into and

consideration of verification principles, provisions and techniques also offer the promise that effective verification systems can be made less intrusive and, therefore, more acceptable to parties concerned about the potential intelligence-gathering capabilities of verification systems.

Applying science and technology to verification: some research examples

Research undertaken under the Canadian Program has been applied to the negotiating and operational phases of the verification process to good effect. As the requirements have been determined, Canada, in assocation with like-minded nations, has shared research results in a manner meant to facilitate the negotiation process.

The application and scope of Canada's activities relating to verification provides an example of a practical programme by which science and technology has been applied to arms control verification issues. For purposes of illustration, a number of issue areas in which Canada has conducted verification research are briefly reviewed below.

A. Chemical weapons

Negotiations on chemical weapons predate this century. The present multilateral negotiations at Geneva, aimed at achieving a comprehensive convention which would prohibit the development, production and stockpiling of chemical weapons as well as their use, are expected to produce an agreement ready for signature by the end of 1992. Having chaired the Chemical Weapons Ad Hoc Working Group at the Conference on Disarmament in 1983, Canada continued to focus on the verification aspects of the Chemical Weapons Convention rolling text. Within the last 18 months, Canada has initiated research and sponsored a number of experiments aimed at quantifying the national and international responsibilities which would have to be assumed by nations upon signature. At the operational level, Canada has undertaken a number of projects at the lower end of technology, aimed at illustrating the utility of collateral analysis as a basic verification method.

B. Nuclear testing

Canadian research, undertaken primarily at the University of Toronto, has focused on the refinement of seismological detection means for the purpose of verifying compliance with a possible comprehensive test ban. Forensic seismology provides the primary means for monitoring nuclear explosions that take place underground. Improved seismographic hardware, Canadian research expertise, and the availability of a vast "proving ground" (the Canadian land mass which bears close resemblance to other regions of nuclear-test-ban verification interest), are all helping Canada remain a notable contributor to this highly specialized branch of seismology.

Canadian seismic experts who have been involved in the Geneva negotiations on this subject for several decades stress that the problem is highly complex, involving many unknowns on the technical side.

The research carried out at the University of Toronto since November 1985 has two components: (a) teleseismic verification using P wave recordings from both the old and the recently refurbished Yellowknife Seismic Array (YKA); and (b) regional (close-in) verification using high-frequency recordings from the Eastern Canada Telemetred Network; a group of stations installed to record earthquakes.

This data-intensive approach is complemented by the development of a new method of signal identification and processing. Rooted in recent advances in mathematical engineering, the "oriented energy approach" has been introduced by the University of Toronto team into seismic wavefield analysis, taking advantage of the recent availability of the three-component, broadband recordings of the refurbished YKA. Preliminary investigations have shown that the new approach facilitates effective recognition of signals which were previously buried in noise. In effect, by turning network stations (instrumentation plus station geological site effects) into nearly identical "clones", fewer recording stations are required per seismic event to establish positive source identification and reliable yield estimation.

The results of this research were shared with member nations of the Conference on Disarmament during its 1991 summer session. The results are now being applied in an operational sense in conjunction with ongoing work at the Yellowknife Seismic Array.

C. Outer space

Outer space is likely to become an increasingly important element of the arms control agenda in the near future. The question of an arms race in outer space has long been on the agenda of bilateral forums between the United States of America and the former Union of Soviet Socialist Republics and multilateral forums concerned with arms control and disarmament.

Canada is committed to the prevention of an arms race in outer space and has remained a firm proponent of maintaining space as a weapons-free environment. Canada supports respect for existing laws and agreements, bilateral and multilateral, governing the use of outer space and views the Conference on Disarmament (CD), through its Ad Hoc Committee on Outer Space (AHCOS), as the forum within which to carefully assess the existing outer space regime as well as possible new measures. We have been active in promoting broad international support for discussions relating to the AHCOS mandate and recognize that multilateral initiatives in the CD context should be complementary to and supportive of bilateral negotiations. We realize that any significant multilateral treaty aimed at preventing the stationing of weapons in outer space should have a strong and practical verification component to it. From a Canadian perspective, research into methods of verifying "non-weaponization of space" has been a focus of concern.

In 1984, Canada initiated a national research programme on the potential problems for verification arising from the dual-use characteristics of certain space systems. "PAXSAT A" was a research project aimed at the feasibility of

space-to-space remote sensing, with satellites used to identify the purpose and function of other space objects. It concluded that space-to-space verification was a feasible concept but identified a number of significant problem areas to be resolved. It recognized that feasibility research relating to other verification concepts (i.e., on-site inspection at a space-launch facility and on the production line) would be extremely useful. Canada shared the results of its PAXSAT research with members of the CD in April 1987.

The Verification Research Program has also sponsored some highly innovative investigations into technical methods to quantify the potential harm that one satellite can pose to another, with the aim of facilitating the development of confidence building and verification measures respecting outer space.

D. Conventional forces

The Conventional Forces in Europe (CFE) Treaty on 19 November 1990 called on the parties to continue negotiations with the goal of building upon that disarmament agreement. These ongoing negotiations - often called the CFE 1A negotiations - have as one agenda item: "measures to limit the personnel strength" of conventional armed forces within the Atlantic-to-the-Urals (ATTU) zone.

Although verifying limitations on military personnel, whether in the CFE or other contexts, will not be easy, it is possible and will likely involve its own unique characteristics. 3/ Unlike much of the military equipment (such as missiles and tanks), which to date have been the focus of arms control and disarmament efforts, personnel seems, at first glance, less susceptible to traditional verification methods. This is true because military personnel are much harder to count with any precision, especially from a distance. There could also be significant definitional problems because of differences in force structures between nations, particularly the greater reliance by some countries on reserve and paramilitary forces. Nevertheless, even here Canadian research suggests that advanced technology could play a role, in particular, the use of overhead imagery and improved personnel management techniques, including the use of "smart cards" for data maintenance and retrieval, could foster complementary methods for verifying personnel strength limitations.

E. Open Skies

The Open Skies proposal should be viewed both as a confidence-building measure (CBM) and as an opportunity to employ overhead imagery as a means of verification in the context of a multilateral treaty. The critical negotiations began in Ottawa, Canada, on 12 February 1990. After three days of ministerial discussion, the delegations, representing the nations of the NATO Alliance and the Warsaw Treaty Organization settled down to three weeks of intensive work on the details of the regime. The delegations next met in Budapest, Hungary, for a three-week session (23 April-10 May 1990). On

9 September 1991, a third round began in Vienna. It reached agreement on a Treaty which was signed on 24 March 1992.

As a practical means of exploring the capabilities and problems likely to be encountered in Open Skies operations and sensors, Canada and Hungary agreed to stage reciprocal observation flights. The first Canadian-Hungarian Open Skies trial overflight took place on 6 January 1990 in Hungary. A Canadian Armed Forces C-130 Hercules transport aircraft flew a large "figure eight" pattern over Hungary, covering a number of Hungarian and Soviet bases. The purpose of the overflight was to test the Air Traffic Control procedures required to stage short notice overflights along complex flight routes involving both military and civilian airspace and numerous altitude changes.

The 1990 trial flight over Hungary achieved its objectives and proved that Open Skies flights would pose no problem for Air Traffic Control in the busy airspace of Central Europe. Because the purpose of the flight was strictly to test Air Traffic Control, the aircraft did not carry sensors.

In order to further the work of the delegations in Vienna, Canada and Hungary initiated a reciprocal trial overflight over Canada. They agreed that the flight should be a more far-ranging test of the emerging regime than had been possible in January of 1990. Accordingly, they decided it would be appropriate to use some of the sensors under discussion in Vienna, and to test some of the procedures outlined in the rapidly evolving draft Treaty under discussion there. The trial flight was completed in Canada during the week of 13-17 January 1992. The results of the trial provided technical information directly relevant to the negotiations.

United Nations Special Commission/International Atomic Energy Agency activities

The verification experience accumulated by the United Nations Special Commission (UNSCOM) is truly impressive. The accumulated inspection experience is potentially precedent-setting in terms of the multilateral verification process. The UNSCOM experience is important particularly in terms of the interrelationship of methods used. UNSCOM has combined information gained from space-based sources, airborne sensors, on-site inspectors, defectors and collateral analysis. UNSCOM, through a unique set of circumstances, has developed a comprehensive verification package which could well serve as a prototype for future multilateral verification. The experience of UNSCOM reaffirms the important role that advanced technology can usefully play in verification matters.

Conclusion

Canadian experience with respect to verification questions indicates that intensive study of the verification issue can not only allay concerns but also facilitate the arms control and disarmament process. A key dimension of this research activity involves the application of science and technology to verification purposes. There are many initiatives that can be undertaken to prepare and develop a range of instruments that could contribute to the

potential for the verification of specific agreements. The work of the Conference on Disarmament Group of Scientific Experts is a good example of this point.

General research into verification techniques also offers the promise that effective verification systems can be made less intrusive and, therefore, more acceptable to parties concerned about the potential intelligence-gathering capabilities of verification systems. If appropriate verification procedures are in place, intentions can be clarified and military capabilities made more evident. In the best environment, adequate and effective verification can help build and maintain confidence between nations; in the worst environment, it can facilitate the taking of such steps as may be necessary to protect national security when non-compliance becomes evident.

Canadian experience with respect to multilateral verification research suggests several principles respecting the application of science and technology to verification purposes, which might be worth further consideration within the Disarmament Commission. These include the following:

1. Technologies and procedures for verification purposes must be continually discussed, researched and updated, if verification capabilities are to remain adequate and effective.

2. Ongoing verification research activities provide an important component of any national or international verification strategy.

3. The continuous exchange of verification research results and related information is an important form of international cooperation in the application of science and technology to verification.

4. The use of advanced verification technologies will involve the availability of appropriate resources in terms of skilled personnel, training, equipment, etc.; not only with respect to data collection but also with respect to data analysis. Such capabilities take time to develop and their development can be facilitated by international cooperation.

5. The synergistic effects among verification methods, whereby different monitoring techniques can complement and reinforce one another, are an important component of verification effectiveness.

6. The use of advanced technology can reduce the level of intrusiveness of a verification system, in the sense of reducing the presence of foreign inspectors on-site and the level of disruption to the internal affairs of States.

Notes

1/ See Official Records of the General Assembly, Fifteenth Special Session, Supplement No. 3 (A/S-15/3), p. 44.

2/ A/45/372 and Corr.1.

3/ For a more detailed discussion see: George Lindsey and Alex Morrison, Verifying Limitations on Military Personnel, Arms Control Occasional Paper, No. 9 (Ottawa, External Affairs and International Trade Canada, 1991).